

Fossil Turtles from Dashanpu, Zigong, Sichuan

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Abstract

Abundant Middle Jurassic turtles are produced from the locality of Dashanpu, Zigong Co., Sichuan Province, but with the exception of several individual descriptions, none of the numerous specimens housed in the Zigong Dinosaur Museum has been reported upon. This paper includes a comprehensive survey of the Middle Jurassic Testudines known to date in addition to conducting further systematic descriptions. The family Chengyuchelyidae fam. nov. is erected to solve the problem of familial assignment during this geologic period in China.

Introduction

The locality of Dashanpu, Zigong, Sichuan Province produces turtles in addition to abundant dinosaurs, but with the exception of a few descriptions of specimens (Ye, 1982; Fang, 1987) in other institutes, all 20 remaining specimens housed in the Zigong Dinosaur Museum have yet to be discussed. In the summer of 1985 the author of this paper was requested by the museum to facilitate more advanced diagnoses of this turtle collection from which a preliminary manuscript was prepared. This text contains a comprehensive survey of the Middle Jurassic turtles known to date in addition to completing the aforementioned manuscript. Additionally, an investigation is conducted into taxonomic problems of Chinese Middle Jurassic turtles and a new family is erected, the Chengyuchelyidae fam. nov., to solve the previous long-standing problem of familial assignment.

I Description

Order Testudines Linnaeus, 1758

Suborder Casichelydia Gaffney, 1975

Infraorder Cryptodira (Cope, 1868)

Family Chengyuchelyidae fam. nov.

Family diagnosis: Paracryptodires are moderate to large in size and found predominantly in the Middle Jurassic. The carapace is oval and lacks conspicuous surface ornamentation. Eight neurals are present, the majority of which are hexagonal with shortened anterior lateral margins. Breadth of vertebral scales is normal or transversely expanded. *Xinjiangchelys* from the upper Middle Jurassic of the Xinjiang Autonomous Region displays only a single large posteriorly expanded suprapygial plate that differs from *Chengyuchelys* in which the suprapygial is either absent or inconspicuously preserved. Anterior and posterior margins of the plastron are both shorter than the carapace with the posterior margin slightly crescentic but not deeply embayed anteriorly. A mesoplastron is situated either within the abdominal scale or between the pectoral and abdominal scales, and joined at the midline of the plastron. *Chengyuchelys* possesses a broad bony bridge with at least three inframarginal scales at each margin. The center of the anal scale penetrates the hypoplastron anteriorly. These latter two characters are not observed in *Xinjiangchelys*, but axillary and inguinal buttresses in addition to a portion of its axial skeleton are preserved in this genus. The two buttresses are extended anteriorly and posteriorly, but unlike the common testudinian condition are not dorsally extended. The angle of the scapular body to the anterior coracoid process exceeds 90°. The lateral process of the pubis is robust, while the pubic symphysis is large and projects strong to the anterior. The ilium is primarily extended posteriorly and does not hang perpendicularly, a condition which resembles several baenids. Humerus and femur are robust, flattened dorsoventral and maintain uncurved shafts.

***Chengyuchelys* Young and Chow, 1953**
***Chengyuchelys baenoides* Young and Chow, 1953**

This species was erected by C.C. Young and M.C. Chow upon specimens recovered from an undocumented locality found during the construction of the Chengyu, Sichuan provincial railway line. The taxon constitutes the first archaic turtle found in China that possess a mesoplastron. For a long time, the only specimens representing this species were the type and paratype, but currently five more specimens from the Zigong Dinosaur Museum collection may be assigned to this taxon: specimens V6507, V8805, ZDM3003, ZDM1, and ZDM3. V prefixes indicate IVPP collections while ZDM are Zigong Dinosaur Museum. The different repositories represent the cooperative nature between several organizations at the initiation of the Dashanpu excavations.

Because specimen V6507 is represented only by the anterior 1/3 of its carapace as described and diagnosed by Yeh (1982), it is regarded as indeterminate to species and hereby omitted from *Chengyuchelys baenoides*.

Specimen V8805 has lost a majority of its carapace, and as such its structure is indeterminate. The plastron however is fundamentally complete. This specimen should be assigned to *C. baenoides* according to the position of the laterally broad and medially constricted mesoplastron which lies within the abdominal scale. Additionally, the femuro-anal sulcus is projected anteriorly and at its center overlaps the hypo-xiphiplastral suture. It appears that this specimen should be regarded as a juvenile due to the presence of a median fontanelle, costo-peripheral vacuities and a poorly-fused entoplastron suture line.

The carapace of specimen ZDM3003 is nearly totally destroyed, but its plastron is relatively well preserved. The plastron structure and position of the femoro-anal sulcus is completely consistent with *C. baenoides*. The bony bridge is broad with three inframarginal scales on each side.

Although specimen ZDM1 is represented only by a partial plastron, the position of the mesoplastron and structure of the anal sulcus are comparable to *C. baenoides*. Other characters shared with this species include three inframarginal scales lateral to the bony bridge on each side, and the last scale being the largest with an expanded posterior margin.

Only the central portion of the plastron represents specimen ZDM3. Two characters unite the specimen with *C. baenoides*: the anterior projection of the femoro-anal sulcus which overlaps the hypo-xiphiplastral suture, and the presence of antero-posteromedially inclined broken sutures within the abdominal scale which should represent the anterior and posterior sutures of a mesoplastron.

***Chengyuchelys zigongensis* Yeh, 1982**

This species was erected upon a specimen derived from Dashanpu, Zigong. The major character discrepancies between this species and *C. baenoides* include a mesoplastron that is not constricted at its center, although it is situated between the abdominal and pectoral scales; a foliate-shaped entoplastron, an exceptionally broad second costal scale, and a fourth vertebral scale that is nearly twice as broad as its length.

In 1987 Q.R. Fang made observations on a portion of specimens from Zigong and assigned specimen I-Z1 (Dashanpu excavation number) to *C. zigongensis*. Fang noted that characters uniting it with this species included the fourth vertebral scale being the broadest, while among the costal scales the second was the broadest. The entoplastron displayed a foliated

morphology, and the relationship between the femoro-anal sulcus and the hypo-xiphiplastral suture was consistent with *C. zigongensis*. The mesoplastron of this specimen, however, was not well preserved.

***Chengyuchelys cf. zigongensis* Yeh, 1982**

There are two specimens assigned to this genus that resemble *C. zigongensis* but are not completely consistent with it, and hence are provided with a referable status. Brief descriptions follow:

The plastron and carapace of specimen ZDM7 are damaged. On the neural plate of the carapace is a longitudinally directed shallow trough. This is a character that is not only observed on the type of *C. baenoides* but also noted on several other species, and which may be regarded as a frequently observed character for the genus. This feature is also present on *C. zigongensis*. The second costal scale on ZDM7 is the largest at 61.5 mm in width and 55 mm in length; however, the most posterior costal scale rapidly decreases in size to 31 mm in length and 20 mm in breadth. On the type specimen this portion of the carapace is missing and consequently cannot be compared. The mesoplastron is situated between the abdominal and pectoral scales, which is consistent with *C. zigongensis*, but it is particularly broadened with a lateral antero-posterior length of 35 mm whereas on *C. zigongensis* this feature measures only 23 mm. Additionally, the anterior margin of the mesoplastron lies extremely distant from the pectoro-abdominal sulcus whereas on *C. zigongensis* these features are in tight proximity.

Specimen ZDM3009 consists of a complete plastron with relatively well-preserved gular and intergular scales. These are features unobserved on both the type specimen and ZDM7. The gular scale is broad, but the intergular scale is nearly square, and the posterior margins of both unite to form a flat and straight gulo-humeral sulcus that is situated anterior to but not connected with the foliate-shaped entoplastron. The anterior and posterior sutures of the mesoplastron are barely distinguishable but are recognized as fundamentally straight and situated between the abdominal and pectoral scales. This differs from the mesoplastra described above, for the central portion of the plate is not constricted, which is a significant character for the diagnosis of *C. zigongensis*. ZDM3009 is quite distinct from the latter species because its anterior and posterior sutures of the mesoplastron lie distant from the abdomino-femoral sulcus, whereas on *C. zigongensis* they are in tight proximity.

***Chengyuchelys dashanpuensis* Fang, 1987**

In 1987 Q.R. Fang from the Chungking (Zhongqing) Natural History Museum erected this species on one specimen out of four studied (Dashanpu excavation number I-T19). Another specimen (I-Z1) was diagnosed as *C. zigongensis*, while the remaining two (I-L1, I-L2) were assigned as *Chengyuchelys* indet. The description for the type suggests that several characters relate to *C. baenoides* while others approach *C. zigongensis*. Those characters that differentiate this species from the other two include a very rounded entoplastron and an extremely medially compressed mesoplastron.

***Chengyuchelys* sp.**

Among the specimens collected at Dashanpu, Zigong, are five that are unidentifiable to species due to their fragmentary nature. These specimens include C.V.00679, I-L1, I-L2, KI-7, and ZDM3004.

C.V.00679 is a Chungking Natural History Museum specimen that consists of a damaged carapace. Ye (1982) made a generalized description of it and provided generic status.

I-L1 and I-L2 were described by Fang (1987) who stated that the specimens were consistent with both *C. zigongensis* and *C. baenoides* by the configurations of their suture lines (I-L2) or the impressions of the suture lines (I-L1). Both possess united mesoplastrons that lie within the abdominal scales, are broad laterally, and constricted medially.

KI-7 is represented by a single carapace. Original specimen notations state that it was collected February 5, 1984. Vertebral scales are predominantly hexagonal and the second costal is the largest. The latter are characters consistent with *C. zigongensis*. It is regrettable that the suture lines are all indistinguishable, making further comparisons are impossible.

ZDM3004 is also represented by a single carapace that lacks all the marginal scales. Original specimen notes indicate the specimen was collected by the Zigong Museum of the Salt Industry. Although the structure of the carapace is not clear, several of the plates are comparable to *Chengyuchelys*, particularly in the presence of a shallow longitudinal trough at the neurals.

Chengyuchelyidae indet.

Two specimens within the Zigong collection differ from the aforementioned species. Further diagnosis is not possible due to the incomplete nature of the specimens, and they may only provisionally be provided familial rank.

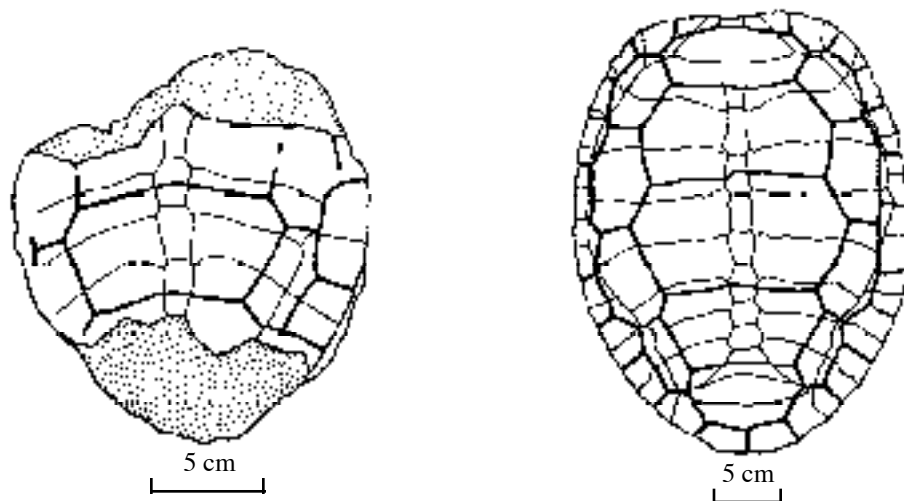


Figure 1. Left: partially preserved carapace from the Middle Jurassic of Zigong. Right: *Dinochelys whitei* from the Late Jurassic of North America (after Gaffney). Note the similarity between the transversely broadened vertebrals and narrow costals but differences in the arrangement of the neural plates.

ZDM3002 preserves only the central and posterior carapace. Original records state that it was collected in November of 1983 within the vicinity of the sacrum of *Omeisaurus tianfuensis* and was provided an excavation number of I-J. The carapace is low and flat with profuse and delicately radiating sculpturing on the surface. Neurals 2-5 have the usual hexagonal pattern with reduced anterolateral margins, but they are extremely broadened, with the breadth at the anterolateral angle of the third vertebral scale 100 mm, or exceeding one-half the breadth of the entire carapace (178 mm). Consequently the costal breadth is greatly reduced to only 22 mm at the contact with the third vertebral, whereas its length is 45 mm. This character, in general, is not observed frequently within testudinian taxa. A further notable character is the extreme broadening of the lateral scales and plates as exemplified by the marginal scale connected to the third costal scale with a length of 33 mm and breadth of 21 mm. The corresponding and underlying marginal

plate is 31.5 mm in length and 30 mm in breadth exceeding the breadth of the costal scale. This is also a relatively rare occurrence among the Testudines (Fig. 1)

Although both plastron and carapace of ZDM3001 are preserved, they have been laterally compressed into convex shells. It is still possible, however, to discern a long longitudinal shallow trough on the neurals. Original specimen records state it was recovered around the cervical region of *Omeisaurus tianfuensis* in 1981 and provided with the excavation number I-J1. This specimen is similar to ZDM3002 described above. It displays transversely broadened vertebral scales, particularly number three, which preserves a central section of only 23 mm, and a breadth of 42 mm is preserved on the right side for a total breadth attaining 84 mm, or nearly four times its length. Length/width measurements of the second, fourth, and fifth vertebral scales also show them all to be transversely broad (mm): 23:82, 22:57, and 26:37.5. Four costal scales on the right side are clearly visible with the first relatively large and broad, the fourth small, and the second and third narrow and long. The lateral morphology is exactly as in the aforementioned ZDM3002 specimen. However, the marginals on ZDM3001 are narrow and long which differs completely from the aforementioned specimen.

The two specimens described above differ from *C. zigongensis* by their transversely broadened vertebral scales and narrow and long costals such that it is very likely that they represent a separate species. The specimens above are not the only fossil Testudines exhibiting this type of morphology, as Ye (1963) described the emydid *Shansiemys latiscuta* also with extremely transversely broadened vertebral scales, although the morphology of the costals was unknown. Moreover, as this latter taxon is obtained from the Pliocene, the temporal interval between it and the Zigong specimens is too extreme to consider affinity. Gaffney (1979) described *Dinochelys whitei* which also displays extremely transversely broadened vertebral scales and relatively narrow and long costals from the Late Jurassic of North America, but neglected to provide a familial rank. Additionally, the Late Triassic *Proganochelys* and Early Jurassic *Kayentachelys* also possess transversely broadened vertebral scales.

II Phylogenetic status of *Chengyuchelys*

To date all the fossil turtles collected from Zigong have been assigned to *Chengyuchelys*, a genus erected by Young and Chow (1953) upon specimens collected from an unspecified locality and stratigraphic position during the construction of the Chengyu railway. Young and Chow noted the presence of a mesoplastron in this taxon, a feature that differed from all other turtles collected subsequently along the railroad line. The shell structure of these specimens resembled those of North American baenids but also maintained autopomorphic characters that promoted the recognition of the new genus and species *Chengyuchelys baenoides*, provisionally referred to the family Baenidae, but upon reflection with some reservations. This constituted the first record of Testudines possessing a mesoplastron in China.

The North American testudinian specialist E. Gaffney (1972) referred to Young and Chow's description of *Chengyuchelys* by stating that the shell description lacked baenid characters (p. 251). In actuality, because the geologic range of the family Baenidae extends from Early Cretaceous to Eocene (Gaffney, 1972, p. 245), it is not appropriate that the Jurassic *Chengyuchelys* be assigned to this family. Subsequently Ye (1982) described *C. zigongensis* but did not assign a familial rank and instead suggested the establishment of an independent family. Fang (1987) described the new taxon *C. dashanpuensis* and also provisionally delayed the familial problem. In 1986, a Jurassic turtle with a mesoplastron was discovered in the Xinjiang Autonomous region. Ye (1986) named this *Xinjiangchelys junggarensis*, but of course there was still no basis for a family assignment. From these publications it is evident that Chinese Middle and Late Jurassic turtles with a mesoplastron have, in a manner, already been recognized as an early and distinct independent evolutionary lineage within the Testudines, and hence may now be

recognized as *Chengyuchelyidae* fam. nov. to include the genera *Chengyuchelys* and *Xinjiangchelys*.

The phylogenetic relationships of the Testudines are disputed among various workers, and particularly in regard to earlier evolutionary relationships. Due to a paucity of specimens, the extent of research is not as thorough as that conducted on the more diversified lineages from later periods. Traditional phylogeny recognizes four suborders within the Testudines: the Proganochelydia which constitute the earliest turtles of the Triassic; the Amphichelydia comprising those from the Jurassic and Cretaceous; the Cryptodira which include derived taxa; and the Pleurodira, which principally encompass southern continent taxa. Gaffney (1975) reassigned taxonomic status of the Testudines above the family rank according to cranial characters and recognized only two suborders: the Proganochelydia and Casichelydia. The former contains the family Proganochelyidae with a few species from the Triassic. The latter includes remaining taxa including the infraorders Cryptodira and Pleurodira. The Amphichelydia were omitted. Gaffney et al. (1987) published a short article that named *Kayentachelys aprix* from the Early Jurassic Kayenta Formation of northeastern Arizona, U.S.A., in which they identified the oldest known cryptodire ancestral to modern turtles. They furthermore erected the family Kayentachelyidae within the megaorder Cryptodira. Accordingly, the current scenario recognizes five families of Testudines prior to the end of the Jurassic: the Triassic Proganochelyidae, and Jurassic Kayentachelyidae, Glyptopsidae, Plesiochelyidae, and the Chengyuchelyidae. The first two are more archaic and possess symplesiomorphic characters such as palatal teeth. The third and fourth inhabit the Late Jurassic or later stages and differ from the Chengyuchelyidae because the Glyptopsidae display noticeable shell ornamentation and the Plesiochelyidae lack a mesoplastron. Obviously then, the Chinese family is an independent lineage of the Cryptodira that arose during the early evolutionary stages of the Testudines. Phylogenetically, it lies relatively distant from the Kayentachelyidae but relatively close to the Plesiochelyidae.

Chronologic problems associated with the members of the Chengyuchelyidae exist, but there is no doubt that those specimens derived from Zigong are Middle Jurassic. *Xinjiangchelys* from the Jungar Basin of Western China was reportedly derived from the middle of the Shishugou Fm. (in the broad sense), which lies slightly above the Middle-Late Jurassic boundary. Depending upon geologic interpretations, the taxon is therefore either Middle or Late Jurassic. Because both the type locality and stratigraphic position for *Chengyuchelys baenoides* are vague, Young and Chow assumed a possible Late Jurassic age for the specimen. The Zigong data now shows the type could be derived from the Middle Jurassic, or possibly that it spans the Middle to the Late Jurassic.

One of the principal characters displayed by *Chengyuchelys* is the presence of an undoubtedly primitive mesoplastron. However, after detailed observations made upon numerous specimens it is noted that this character is inconsistent, with some situated within the abdominal scale (as on *C. baenoides*, *C. dashanpuensis*, and *Xinjiangchelys junggarensis*) and some lying between the abdominal and pectoral scales (*C. zigongensis*). Moreover, the central portion of the mesoplastron on some individuals is distinctly constricted (*C. baenoides*, *C. dashanpuensis*), while on others it is not (*X. junggarensis*, *C. zigongensis*). These data suggest that the mesoplastron gradually reduces through testudinian evolution. This reduction occurs first through the constriction of the central portion of the plate; secondly, the central portion becomes lost; thirdly, there are only the remnant extremities; and finally the entire mesoplastron is lost. It may thereby be concluded that a relatively primitive condition exists with a mesoplastron between the pectoral and abdominal plates with an unconstricted center. The derived condition would then be recognized as a constricted mesoplastron within the abdominal scale. This scenario is supported by observations on the oldest known Triassic turtle *Proganochelys quenstedti* which displays an unconstricted mesoplastron located between the pectoral and abdominal scales. The evolutionary scenario described above, however, is hardly plausible because the North American Jurassic *Kayentachelys* possesses a medially constricted mesoplastron, but the Middle Jurassic

C. zigongensis possesses a mesoplastron that lies between the pectoral and abdominal scales, and unlike the former is not medially constricted. Furthermore, among the *Chengyuchelys* obtained from the Middle Jurassic Dashanpu locality of Zigong, as stated above, some display mesoplastrons within the abdominal scale, while others possess mesoplastrons that lie between the abdominal and pectoral scales. Some are medially constricted while others are not. Apparently, the evolutionary morphology of the mesoplastron is neither monomorphic nor monolinear, such that its morphology may be subject to specific variation. The general evolutionary tendency, however, is still consistently toward its reduction and finally absence.

Two genera and four species of Middle Jurassic turtles are currently recorded from Sichuan Province and northern Xinjiang. Additional Jurassic turtles have also been found in Baicheng (Bay), south of the Tianshan Mts., Xinjiang, and from Xining, Qinghai Province, but regrettably the specimens are fragmentary. Additional specimens from Canzimiao, Chenxi Co., Hunan Province are also believed to be Middle Jurassic (Ye, 1983). Consequently, it is evident that in the Middle Jurassic of China there was a relatively wide distribution and abundance of turtles existing during the early phase of their evolutionary history. Combined with the knowledge of older specimens from the Lower Lufeng Fm., of Lufeng Yunnan, and the numerous specimens obtained from the Late Jurassic, it is evident that China is one of the more important locales for the study of the early evolution of turtles. Ckhikvadze (1987) from the former Soviet Union stated that realization of the genuine systematic relationships between the Testudines is not possible without consideration of the Asian Mesozoic and Early Tertiary data.

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